USAWC STRATEGY RESEARCH PROJECT

SPACE-BASED POSITIONING, NAVIGATION & TIMING POLICY (THE TENSION BETWEEN MILITARY AND CIVIL REQUIREMENTS)

by

Colonel Bruce Smith
United States Army

Dr. William Pierce
Project Advisor

U.S. Army War College
CARLISLE BARRACKS, PENNSYLVANIA 17013

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ABSTRACT

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Since the Air Force declared the Global Positioning System (GPS) fully operational in 1995 it has transformed U.S. military operations as well as civil services and business. Recognizing the vital role GPS has in both enabling modern U.S. military operations as well as powering the global information-based economy, President Bush signed the National Security Presidential Directive (NSPD): U.S. Space-Based Positioning, Navigation, and Timing (PNT) Policy in December 2004. The policy's intent is to protect and advance U.S. military capabilities while at the same time protecting and advancing U.S. civil and commercial PNT interests, including the economic well being of the U.S. space-based PNT industry. The policy seeks to balance competing PNT security and civilian requirements, but gives priority to military and security interests. How well the policy will be able to meet these often competing requirements is still undetermined. In light of Galileo's forthcoming challenge to GPS's civil and commercial viability, the effectiveness of the President's policy is questionable concerning the U.S.'s ability to protect and promote GPS's civil and commercial interests. This research paper will determine if the recently signed National Security Presidential Directive; Space-Based Positioning, Navigation, and Timing Policy protects Global Positioning System civil applications or will it cede them to the European Union's forthcoming Galileo PNT system, and if so, what are the ramifications?

SPACE-BASED POSITIONING, NAVIGATION & TIMING POLICY
(THE TENSION BETWEEN MILITARY AND CIVIL REQUIREMENTS)

Introduction

Military, commercial and civil activities have evolved in the last ten years, since the United States Air Force declared the Global Positioning System (GPS) fully operational. The United States initially developed GPS to provide space-based positioning, navigation, and timing (PNT) services to its military forces. These GPS services have become the glue that binds together modern military operations.[1] U.S. public law goes so far as to call GPS "vital to the effectiveness of the United States and allied military forces and to the protection of the national security interests of the United States."[2] However the very nature of GPS, in addition to its military utility, has also evolved in the last ten years. Space activities are no longer the sole prerogative of national governments. Commercial space applications, investments, and systems far outnumber their government counterparts. Space commerce, to include civil GPS applications, is enabling the new information-based economy.[3] Today space-based positioning, navigation, and timing services are critical to both U.S. and global economic wellbeing, contributing billions of dollars to their economies. GPS is powering global industry and commerce, reaping millions of dollars in profits for U.S. PNT firms. Despite its military origins and capabilities, GPS has essentially become a civilian service, or global utility.[4] GPS is a dual-use technology, with both military and civilian utility.

The growing importance of space-based PNT services to their economies has driven the European Commission (EC) to build its own independent satellite navigation system. The EC, with the European Space Agency, is developing a system called Galileo in order to gain a share of the world's growing space-based PNT market, as well as further develop its own aerospace industry. Galileo, when operational, will provide improved and modernized civil and commercial services, but unlike GPS it will not provide dedicated military capabilities. When it becomes fully operational in 2010, Galileo will be the first viable commercial competitor to the GPS system and will have the potential to transform the commercial satellite navigation business, breaking GPS's current monopoly.

Recognizing the vital role GPS has in both enabling modern U.S. military operations as well as powering the global information-based economy, President Bush signed the National Security Presidential Directive (NSPD): U.S. Space-Based Positioning, Navigation, and Timing Policy in December 2004. The policy continues to treat GPS as a dual-use asset. It seeks to balance competing PNT security and civilian requirements, while recognizing that for the first time GPS will have a commercial competitor, Galileo. The policy's intent is to protect and advance U.S. military

capabilities while at the same time protecting and advancing U.S. civil and commercial PNT interests, including the economic well being of the U.S. space-based PNT industry. How well the policy will be able to meet these often competing requirements is still undetermined. In light of Galileo's forthcoming challenge to GPS's civil and commercial viability, the effectiveness of the President's policy is questionable concerning the U.S.'s ability to protect and promote GPS's civil and commercial interests. This research paper will determine if the recently signed National Security Presidential Directive; Space-Based Positioning, Navigation, and Timing Policy protects Global Positioning System civil applications or will it cede them to the European Union's forthcoming Galileo PNT system, and if so, what are the ramifications?

This paper will answer these questions by first reviewing the history and development of U.S. PNT policy and the corresponding development and maturation of the GPS system. Second, the paper will examine the growing conflict between military and civilian PNT interests and Europe's increasing apprehension of GPS's dual-use nature which resulted in its recent decision to build Galileo. Next, the paper will compare Galileo's and GPS's civilian capabilities and examine how the PNT environment is changing, as civilian investments and interests are overtaking security and military applications. The paper will then critique the 2004 NSPD and determine if the policy protects U.S. civilian PNT interests or in fact undermines them and gives Galileo an advantage. Lastly, it will address the ramifications of ceding GPS civilian applications to Galileo and propose measures the U.S. Government can take to mitigate the consequences of the NSPD in order to keep GPS competitive in the civilian PNT market place.

History of GPS Policy

President Clinton signed the first GPS policy, Presidential Decision Directive/National Science and Technology Council-6, U.S. Global Positioning System Policy in March 1996. His policy was signed only one year after the Air Force declared the GPS constellation fully operational. At the time, the U.S. understood the military potential of GPS, as demonstrated in the Gulf War, but had not yet realized the full commercial potential. GPS was primarily seen as a military system that had civilian utility. The 1996 policy sought to actively promote GPS civil applications and the U.S. space industry as well as giving the civil community a greater voice in the system's development, management, and operations.[5] In recognition of GPS's vast commercial potential President Clinton further directed, in May of 2000, the military to stop deliberately degrading the civil signal and provide commercial users the same accuracy as the U.S. military. [6] His directive sparked a widespread interest in and adoption of GPS by civilian users, worldwide.

By 2004 it was not necessary for the United States to promote commercial GPS acceptance. The issue had become how to manage and de-conflict the growing tension between the competing interests of military and civilian users. This management problem was compounded by the news that Europe would build its own civil space-based PNT system, which would have the potential to harm the military utility of GPS as well as undercut its commercial monopoly. As space-based positioning, navigation, and timing services have become essential to both military and civilian operations, the U.S. government has been challenged to develop effective policies to manage the system, safeguarding and enhancing its military capabilities while at the same time promoting commercial acceptance and adoption. Space policy must address growing space commercialization and the realization that national space interests are broadening beyond traditional military concerns. As Scott Pace notes in his article, Space Commerce, "The reality of Space Commerce has resulted in new and unique public policy conflicts. These conflicts arise from the possible military uses of space technology known as 'dual-use.'"[7] National policy must evolve to address the growing conflict between commercial space interests and traditional security or military interests. Space policy must also expand to protect the interests of civilian users and providers, as their interests are now national interests as well. In his paper, *The International Development of Space and its Impact on U.S. Space Policy*, Colonel Dale L. Hayden recognizes U.S. space policy must evolve, as the nation's space interests have evolved, "The question U.S. policymakers must answer in an era of a dramatically altered landscape is what is the best approach to ensure national space interests are protected."[8]

In December 2004 President Bush sought to address the shortcomings of the Clinton policy, and address the rapidly changing PNT environment with his National Security Presidential Directive. His policy's purpose, only the second to address the Global Positioning System, is to establish guidance and implementation actions for space-based positioning, navigation, and timing programs and activities. The new policy concerns GPS applications for U.S. national and homeland security, civil, scientific, as well as commercial activities.[9] During the decade between Presidents Clinton's and Bush's policies, GPS grew into a global utility whose multi-use services are both integral to U.S. security and an essential element of the world's economic infrastructure. President Bush's NSPD recognizes the Global Positioning System's unique dual-use technology status and seeks to address the requirements and needs of the various users by establishing a set of policy goals and priorities, as well as a management mechanism to de-conflict competing requirements. The recently signed NSPD has three stated purposes. First, the policy provides guidance for operation, development, modernization, sustainment, and acquisition of the GPS. Secondly, the policy provides much more definitive and authoritative direction concerning GPS

operations and protections for U.S. and allied security applications, as well as instructions concerning the denial of adversary access to and exploitation of the GPS system. Lastly, the policy provides the foundation for international cooperation and GPS foreign access. This last stated purpose includes U.S. – European cooperation in civil, commercial, and scientific PNT applications provided by GPS and or Galileo.[10]

The Genesis of PNT and the GPS System

The genesis of GPS began in 1973 with the Naval Research Laboratory's idea to develop a navigation system based on the precise timing system it had developed: Timation.[11] The first developmental Block I GPS satellite was launched on 22 February 1978.[12] The GPS was intended and developed for military use, providing navigation and timing signals for submarines, surface ships, and long range aviation. However in 1983, while the system was in development, President Reagan fundamentally changed the nature of the program. Korean Airlines flight KAL-007 was shot down in the Soviet Union when its navigation system malfunctioned and it inadvertently strayed into Soviet airspace and over flew sensitive military facilities. In the ensuing uproar the President revealed the existence of the GPS and offered its use to the civilian world. With his offer, GPS became a dual-use system and a host of new issues developed, which had to be resolved through policy, hardware design, software functions, and encryption.

Despite the fact that GPS was not yet fully operational it played a major role in Desert Storm and demonstrated enormous military potential. By January 1991 sixteen satellites were in space, on orbits designed to provide maximum coverage to the Persian Gulf region. GPS provided 22.5 hours of two-dimensional service and almost 17 hours of three-dimensional service daily. [13] The U.S. military desired the ability to engage targets precisely, with minimum ordnance or collateral damage, and without exposing aircraft and aircrews to hostile fire. Furthermore, it wanted this capability in all weather conditions, day or night. Laser guided bombs and homing missiles provided precise capabilities but were limited by poor visibility and endangered aircrews who had to loiter nearby. GPS changed how the military targeted systems. GPS guided weapons enabled the U.S. to attack in any type of weather, regardless of visibility. The U.S. Air Force used GPS to coordinate the movement of large numbers of aircraft and control large air strikes, often made up of aircraft converging from many locations and directions.[14] Though not initially designed for the Army's use, GPS proved invaluable for the ground fight. GPS made possible the Army's "left hook", as GPS signals enabled units to navigate through the largely featureless and road-less desert to precise points. By the end of Desert Storm the U.S. Military realized it had an enormous advantage

with GPS, whose capabilities touched every facet of operations.[15] Throughout the rest of the 1990s the U.S. military continued to develop new and expand existing GPS signal applications.

Simultaneously civil and commercial interest in GPS began to grow. Precise navigation and timing applications found a ready market. Manufacturers fitted GPS receivers into everything from cars, civil aircraft, watches, to cell phones, and personal digital assistants. GPS receiver prices fell while manufacturers also reduced receiver size and weight. GPS evolved from an expensive novelty to a commercial product that added value in numerous applications.

Military and Commercial GPS Use Today

The proliferation of GPS throughout the U.S. military is astounding, given that the system has been fully operational for only ten years. The use of GPS in military platforms, systems, and weapons is approaching ubiquity.[16] GPS has transformed U.S. military operations, enabling precision strike, precision maneuver, just-in-time logistics, operational timing and synchronization, and command and control. Since Desert Storm the U.S. has considered space an essential element of U.S. military dominance and made military operations increasingly dependent on space assets and technologies, including GPS.[17] During Operation Iraqi Freedom, in 2003, GPS permitted the U.S. to drop more than 6000 Joint Direct Attack Munitions (JDAMS) alone.[18] In fact, Secretary Rumsfeld called the ongoing war the most accurate ever.[19] Satellite positioning, navigation, and timing provided by GPS, has become a cornerstone of U.S. military capability and is a unique force multiplier across the entire spectrum of military operations.

Yet at the same time the utility of GPS to global commercial navigation, communication, and above all commerce, has also made it an indispensable world asset.[20] GPS has become an economic engine for growth and has grown into a 6 billion dollar a year business.[21] GPS civil and commercial usage is growing exponentially across the globe. In 1998 the International Telecommunications Union reported that there were 159 civil, commercial, and consumer GPS applications; by 2005 that number had grown to 270.[22] The information revolution, driving today's advanced economies, has extended into space. Often referred to as the "world's fifth utility", GPS is improving resource exploration, managing air, train, ship, and auto traffic, synchronizing banking transactions and electrical power grids as well as routing internet communications.[23] GPS's economic impact is staggering. In 2002 GPS is estimated to have had $12 billion in revenues, and is projected to grow 20% annually.[24] The U.S. government expects to receive between $6 - $7 billion dollars from individual federal income taxes of those working in the GPS industry in the decade between 2000 and 2009.[25] Estimates indicate that the disruption or shutdown of the U.S. GPS would cost Europe alone between 130 and 500 million Euros a day.[26] Civilian use of GPS is

far outpacing military usage. World wide the ratio of civilian to military users is believed to be 100 to 1.[27] Consequently, as Everett C. Dolman states in his book Astropolitik, "The United States military now finds itself in the curious position of having to maintain a network of satellites that contributes billions of dollars to the world economy, and should it fail to be maintained, would have global civilian negative ramifications."[28] GPS is the model dual–use system. The large scale civilian adoption of GPS has complicated the management and operation of the system and has far reaching ramifications for the military and the U.S. Government.

Conflicts in Dual-Use Technology

There are inherent conflicts caused by GPS's dual-use nature, as national interests related to defense, commercial, and foreign policy objectives compete with each other.[29] Actions taken to promote PNT market share and economic growth are not necessarily consistent with national security. Civil applications require transparency, open standards, and innovation. On the other hand, national security requires confidentiality, protection, and improvements for military operational objectives.[30] Military and security proponents have sought to protect and preserve the asymmetrical military capabilities GPS has provided the last fifteen years. They have been concerned with providing adversaries positioning, navigation, and timing capabilities and technology that improves their capabilities or lessens the United States'. As Prussian strategists once worried about how their expanding national railway system would aid invaders, similarly U.S. military planners are concerned about the effects of GPS access to belligerents.[31] The Department of Defense has been keen to protect its PNT advantage, seeking to limit the proliferation of GPS technology. The U.S. has modernized GPS to meet military requirements, but has not given the same attention to civilian modernization needs. This thinking, as well as these actions, has directly impacted the world's perception of the United States' intentions as related to GPS and their willingness to trust the United States to continue to provide this global utility. Americans have tended to think of GPS as a military utility that civilians are permitted to use, (reflecting the military origins of GPS) while much of the rest of the world sees it as a global utility. [32] European and other civilian users want open GPS architectures, added features that drive innovation and provide increased accountability, integrity, reliability, and certifiably all at U.S. expense. Space related commerce is being driven by information markets which are sensitive to transparent accounting and the free flow of information.[33] Military restrictions on GPS's transparency, accountability, and integrity hinder its ability to compete in these commercial markets.

Europe's Decision to Build Galileo

The astounding military and commercial success of GPS has not gone unnoticed by the rest of the world, and in particular Europe.[34] Europe, through NATO, has adopted GPS as its military positioning, navigation, and timing service. Simultaneously, civilian GPS applications in Europe have grown increasingly important to the point that the European Commission (EC) has decided it must build its own satellite navigation system. Europe's rationale to build Galileo is based on three stated needs. First, the fact that GPS is a military system, controlled by the United States Air Force, initially spurred the EC to consider building Galileo.[35] Though the United States has repeatedly stated that it will make the GPS signal available on a worldwide, continuous basis, the U.S. Air Force maintains the ability to manipulate, degrade, or deny the GPS signal, if national security considerations warrant.[36] The EC sees the U.S. military's ability to manipulate the GPS signal as a threat to its own interests. The EC is dependent upon satellite navigation data. It does not trust the U.S. to manage this critical capability, and must protect itself from potential harm caused by U.S. decisions with regard to the GPS signal. Secondly, the EC estimates that Galileo has a potential market worth of $ 9 billion per year for member nations, and it could create 140,000 high tech aerospace jobs.[37] Most importantly, Europeans associate Galileo's importance with a reduced dependence on the United States and an increase in their own sovereignty. [38] Seeing its large and expanding reliance on satellite PNT data, Europe envisions a larger role and voice for itself in control and utilization of this information utility. [39] It has simply become untenable for Europeans to subordinate their own desires and voices to the U.S., and rely on American benevolence for satellite navigation information.

Galileo Capabilities – What it Provides in Contrast to GPS

Galileo provides several tangible, as well as intangible, improvements over GPS. Tangible benefits include; signal integrity, certifiable PNT data, improved accuracy, timeliness, and responsiveness to the commercial market. The Galileo system is designed to provide users a signal integrity report, signal degradation, and unreliability information is provided in real time.[40] Users can or will receive integrity data, for a fee, through their receivers. This feature will alert users to errors in the positioning, navigation, or timing information and give them the ability to immediately, on a worldwide basis, implement alternative PNT procedures or activate backup systems. GPS does not have this feature. GPS signal integrity is provided by government or commercial augmentation systems, such as the Wide Area Augmentation System (WAAS), in a specific geographic region. Users who are not able to access the augmentation systems are unaware when GPS signal integrity is degraded or compromised. Galileo has a competitive advantage over GPS in that the EC is willing to certify its PNT data, while the U.S. is not willing to

certify PNT data provided by GPS. This willingness to certify data, for liability purposes, gives Galileo users an additional protection not provided to GPS users. Additionally Galileo will provide new services in the near term; increased signal power, higher data rate messages, and modern signal design – all designed specifically for the commercial and civil markets. These same services will not be provided by GPS in the near term. Galileo provides several intangible benefits as well. Galileo is a civil system. It is not tied to the military and is not constrained by military requirements. Technical applications, schedules, and services are dictated by the market and not by military requirements or budget processes. It is feasible that Galileo will be much more adaptive and responsive to the PNT market than GPS.

The Nature of PNT Competition is Changing

GPS is a product of the cold w ar. It was conceived and developed in the midst of the rivalry between the U.S. and the Soviet Union, in order to provide the U.S. military a decisive advantage. At the same time the Soviet Union developed its own satellite navigation system; GLONASS. GPS and GLONASS were competitors only in the sense that they enabled rival military forces. The world, to include the space environment, has changed since the fall of the Soviet Union. Today the main competitor in space is no longer the Soviet Union, but other market economies.[41] Military GPS is not competing with GLONASS; instead civil GPS will compete with Galileo. Competition is taking place in the market place, leading to new risks as well as opportunities from the proliferation of advanced technologies and information.[42] The prize is not military superiority, but economic advancement, technology control, market share, and billions of dollars. The competition, the prizes, and the competitors are evolving. The United States is powerless to prevent the proliferation of other PNT systems. However, the United States can successfully compete and shape the competitive PNT environment with the appropriate policies.

GPS Policy Will Cede Some Portion of the Civil Applications to Galileo

The United States Government, in the NSPD, has sought to develop a policy that balances both military and civil requirements, and give an increased voice to the civil user community. However the policy makes clear that despite the importance of civil users and their requirements, military and security applications have preeminence, "While the growth in civil and commercial applications continues, the positioning, navigation, and timing information provided by the Global Positioning System remains critical to U.S. national security, and its applications are integrated into virtually every facet of U.S. military operations. United States and allied military forces will continue to rely on the Global Positioning System military services…."[43] The President's priorities are not

surprising and echo previous policies. Per James Lewis, "The goal of U.S. national space policy is to ensure that the United Sates continues to have superior space capabilities to any potential opponent."[44] Yet, by promoting security interests first, this policy threatens to undermine U.S. commercial space interests, including PNT market share, technology lead, and profit margins. Previously the world's PNT users accepted GPS services that were primarily driven by national security considerations, and the fact that the system was dual-use. But PNT has become too important and an integral part of civilian business and services to allow it to be subordinated and civilian applications sub optimized to support military use. Attitudes are changing among GPS users. Civil and commercial PNT users are no longer willing to be constrained by military requirements. "There are indications that this convenient symbiosis of civilian and military applications may be ultimately unsustainable."[45] GPS's military considerations directly conflict with civil and commercial user's desires and requirements, adversely impacting its usefulness and competitiveness.

Civilians are interested in improvements in GPS timing, accuracy, precision, availability, and reliability. They are looking forward to enhanced GPS functionality and the creation of new products and services, and the subsequent opening of new markets.[46] Frankly the military, or the U.S. Government, has not adequately addressed civil GPS requirements, and provided for their interests. Civilian users are growing increasingly frustrated with sub optimized performance and the lack of modernized applications, and are looking for alternatives, as the U.S. Government is unwilling to meet their expectations. Rather than prioritize civilian PNT requirements, government policies and GPS system management are optimized to support military and security considerations and applications. The Air Force's objective has revolved around military PNT needs, in which it has been highly successful. "There is little real incentive for the Air Force to optimize GPS services for civilian and commercial use."[47] Many in the civil community argue that the biggest drawback to GPS is the fact that it is controlled by the U.S. military, which they see as an impediment to PNT capabilities continuing to mature and meet civilian requirements. Furthermore, they object to the fact that not only do military applications take precedence over civil ones, but that GPS must compete against other military systems, i.e. aircraft, ships, tanks, etc., for funding in the Pentagon's budget process.[48] Limited military budgets and competing priorities together constrain GPS's civilian capabilities and utility. GPS modernization is one example of how the government is placing military PNT requirements before civil requirements to the detriment of U.S. commercial interests. GPS will not be fully modernized, with improved signal integrity, power, data rates, etc., until 2020. Galileo is expected to be fully operational, with these capabilities, in 2010. This ten year gap in development is the direct result of GPS's military affiliation. The modernization schedule is driven

by military operational considerations and federal budgets rather than market forces. Many civilian PNT users will not wait a decade for GPS to catch up to Galileo and provide similar capabilities.[49] They will take advantage of the services provided by Galileo, at the expense of U.S. manufacturers and service providers.

The 2004 NSPD is an improvement over the 1996 policy in regard to both a vision and a management mechanism to improve response to civilian PNT requirements. The new policy is an attempt to advance civilian PNT interests, and provide an increased role for civilians in GPS management, within the constraints imposed by security interests. In the past, the 2004 policy may have placated the civilian GPS community. However, the environment has changed with the introduction of Galileo. Civilian PNT users do not have to settle for GPS shortcomings, caused in large part by its dual-use nature, with military applications driving development. Galileo will not be a dual-use system and hamstrung by military requirements. Galileo will be more responsive to the wishes and timing of the civilian, global PNT market than GPS. Galileo promises to provide civilian users the system capabilities they want, within the timeline they demand, without the constraints caused by U.S. security policies. The President's PNT policy, by promoting military requirements first, undermines the commercial competitiveness of GPS and unintentionally makes Galileo increasingly attractive to civilian PNT users. The 2004 NSPD fails to protect all civilian GPS interests and consequently the U.S. will cede a portion of its GPS civil applications and civilian market to Galileo.

Ramifications of Military Preeminence in the Policy

If in fact the U.S. does cede a portion of its GPS commercial market to the Europeans, there are significant ramifications to the nation that are both immediate and long term. Most obvious and immediate would be the economic impacts caused by changes in the PNT market place. The U.S. must consider the ramifications of a military first policy and the associated risk of losing the revenue produced by a healthy American GPS industry.[50] While the individual satellites are expensive, "the money is on the ground, not in space."[51] The satellites, ground stations, and control equipment are not the large economic drivers. The majority of PNT commercial revenue is from the sales of ground-based receivers, and the subsequent packaging and applications. Today those receivers, packaging, and applications are based on GPS and are built and provided by American manufacturers. Today 40 out of 46 GPS receiver manufacturers are based in the United States, and the other 6 possess U.S. licenses for production.[52] It is highly likely that in the PNT realm the economic balance of power will shift to Europe. As PNT user equipment, applications, and services are developed for Galileo the relative market for GPS equipment will decline. It is natural that

European manufacturers will want to build the receivers and develop the applications, reaping Galileo's economic benefits, similar to U.S. industry with GPS. The United States remains concerned about whether Europe provides U.S. manufacturers access to Galileo technical information in order to build receivers and develop applications that could be potentially compatible with GPS. Europe's stated desire to increase opportunities for European firms has raised concerns that the EC might enact regulations that restricted non-European companies from having access to critical Galileo specifications and competing in this new market.[53]

A longer term issue that is yet to be resolved is the question on how the PNT market place will evolve and be managed. Will the EC let the free market determine GPS and Galileo's positions and shares, or will it take action to promote or mandate Galileo's usage? Critics have stated that it is unlikely that the market will accept all Galileo services unless it is somehow regulated and mandates have been imposed.[54] Galileo's business model depends upon commercial fees for operations and is predicated on continued global navigation satellite service growth. GPS on the other hand relies on government funding and there are no user fees. The fact that GPS is free, while some Galileo services will require user fees, may undermine Galileo's acceptance in the PNT market. This dependency has raised concern that the European Union might employ strategies to ensure Galileo PNT information is required in some markets and/or that Galileo will be regulated and mandated as the PNT provider.[55] The European Commission could mandate that private firms, as well as public entities, must use Galileo within its jurisdiction in order to ensure sufficient revenue streams to keep the system operating. Such a mandate would further erode GPS usage within Europe and reduce overall need for U.S. manufactured GPS receivers and user applications. Additionally the United States is concerned that the EC might try to change accepted commercial PNT standards. As envisioned, Galileo is very similar in functionality to GPS. However, depending on design specifications, it has the potential to create new PNT technical standards in relation to frequency spectrum management and signal structures.[56] Technical changes imposed by Galileo, intentionally or unintentionally, could force GPS to adopt similar changes in order to remain competitive in the commercial realm.

Mitigation of Loss of Civilian PNT Market

Initially the United States government tried to dissuade the Europeans from building Galileo when they began serious consideration of the system. The U.S. sought to maintain its military asymmetric advantage provided by GPS, preventing the proliferation of satellite navigation technology, as well as maintain its almost complete civilian PNT monopoly. The United States failed. The Europeans decided to build Galileo. Consequently the United States then tried to

shape Galileo's specifications, design, and operational parameters in order to safeguard its own GPS capabilities. In the words of Charles W. Freeman, "A wise state yields gracefully to what it cannot resist, while attempting to wrest every advantage from unavoidable adjustments to emerging realities."[57] Faced, with the inevitability of Galileo, the U.S. agreed that GPS and Galileo could benefit both civil and commercial users, provided the two systems were compatible and interoperable, and began serious discussions with the Europeans.[58]

The United States engaged the European Commission over a four year period, before reaching a framework agreement in June 2004. As the framework discussions were ongoing many in the U.S. GPS community, including those in the U.S. commercial space industry, began to realize it was in their own best interest to cooperate with the Europeans in the development of Galileo. They surmised that adopting a cooperative approach would be more advantageous than taking a competitive stance. Among the issues that had to be resolved were signal allocation, protection from unauthorized use of the signal, regulatory restrictions, and systems interoperability. [59] Representatives from Lockheed-Martin, a GPS satellite prime contractor, stated that collaboration would actually improve and protect GPS capabilities. Lockheed saw an opportunity for Galileo and GPS to work to together to protect the radio frequency spectrum by adopting a unified stance within the International Telecommunications Union. GPS representatives working alone would not have the same influence and ability to protect the radio frequency spectrum for satellite navigation.[60]

The cooperative framework agreements that the United States obtained with the Europeans were reasonably successful in protecting GPS, as well as establishing a basis for GPS-Galileo cooperation. The agreement not only preserved GPS military capabilities, protecting the military frequency spectrum, but also ensured a level competitive environment for U.S. manufacturers for Galileo equipment.[61] More importantly the framework established an ongoing process for U.S. and EC cooperation through Galileo's development, deployment and its subsequent operations.[62]

The U.S. is also working to improve GPS's civil competitiveness within the constraints imposed by its dual-use nature. The 2004 NSPD gives greater voice to civil and commercial proponents. In 1996 the NSTC-6 established an interagency GPS Executive Board, co-chaired by the Departments of Defense and Transportation, with the Department of State as the only other member. The Defense Department was responsible for acquiring and operating the system, while the Transportation Department was charged to serve as the lead agency for all federal civil GPS matters and to promote commercial applications. Both departments were charged to coordinate with other departments and agencies as necessary, in order to promote the policy's goals. In contrast, the 2004 NSPD sets up a National Space-Based PNT Executive

Committee, co-chaired by the Deputy Secretaries of the Departments of Defense and Transportation, similar to President Clinton's policy. However the Departments of State, Homeland Security, and Commerce as well as National Aeronautics and Space Administration (NASA) and the Joint Chiefs of Staff are now permanent members of the committee with a voice in GPS management. Additionally, the NSPD established a Position, Navigation, and Timing Coordination Office to provide staff functions for the executive committee, and is responsible for day to day interagency management, policy coordination, and foreign interactions. Lastly, the NSPD established a Position, Navigation, and Timing Advisory Board composed of space industry representatives. The advisory board's role is to ensure that the Executive Committee fully understands industry concerns and helps shape policy that promotes overall U.S. space industry health. The new management structure gives greater voice to GPS civil and commercial users and recognizes the tremendous economic role GPS plays in the 21 st century.

In addition to resourcing and implementing new management practices, the President's directive also charges the Department of Defense to continue modernization of the GPS system, as well as navigation warfare capabilities.[63] Galileo will be a more modern and robust satellite navigation system than GPS when it becomes fully operational in 2010. Its advanced features will be attractive and capture a portion of the PNT market from GPS. However the U.S. Government can mitigate the loss of market share by continuing with its plans to modernize GPS. Ideally the U.S. Government should not only keep GPS modernization on schedule but should accelerate it. Furthermore, the U.S. must improve the perception that GPS is a trustworthy and reliable resource for the global community and that the nation remains committed to its upkeep, continued development, and modernization.[64] In summary the best course of action to mitigate the risk to GPS is to cooperate with the EC and at the same time improve GPS capabilities through both policy and technology.

Conclusion

The 2004 U.S. Space-based PNT Policy is a good policy. The NSPD recognizes the vital role that GPS plays in national security as well as its importance to the world's economic health. The policy seeks to promote a balance of military and civil interests and requirements and continues to manage GPS and PNT capabilities as a dual-use asset and resource. However, the policy makes clear that it is not possible to meet all requirements equitably. Despite the increasing economic importance of space-based PNT capabilities and services to the U.S. and world economies, U.S. policy places civilian PNT applications and interests subordinate to military and security considerations. The President's policy makes military applications preeminent with the

understanding it will impact GPS's civil competitiveness. This is the correct position, and in reality, the only position the President could take. The nation is at war and the military requires unique and secure GPS capabilities in order to operate effectively. The President is constitutionally charged with defending the nation against all enemies, foreign and domestic. GPS enables and enhances his ability to do this through military applications. Legally as well as morally, the President could not subjugate GPS military functionality to civilian and commercial interests and thereby undermine a capability of the United States military.

The policy's subordination of civilian PNT interests to military considerations puts the U.S. PNT industry at a commercial disadvantage in comparison to Galileo. The policy provides Europe with a more favorable opportunity to build Galileo, as GPS is constrained by its military ties and functionality. GPS cannot offer the same advanced civil capabilities, nor can it meet the timeliness demanded by civilian PNT users. U.S. policy unintentionally makes Galileo increasingly attractive to the commercial market place, and as a result, the policy will have the affect of ceding a portion of GPS's civilian market to Galileo.

The government recognizes this vulnerability and has sought to reduce the risk to GPS and the U.S. PNT industry by mitigating the policy's impact. The NSPD gives increased voice to civilian users in the management, development, and operations of the GPS, as well as making an increased commitment to its modernization and support of the U.S. PNT industry.

The NSPD cedes some GPS civil applications, and corresponding civilian PNT market share, to Galileo that will cost the U.S. PNT industry in terms of jobs and dollars. As costly as this loss is, the alternative is more so. The United States can not afford to jeopardize its national security by subjugating military PNT requirements to civilian PNT desires and interests.

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